Ecosystem Committee Report to the North Pacific Fishery Management Council

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DRAFT Minutes of the Ecosystem Committee Meeting January 23-24, 1997
The Alaska Fisheries Science Center Workshop on Ecosystem Research

Background

The NPFMC's Ecosystem Committee was formally established by the Council in June 1996 following a recommendation by the Scientific and Statistical Committee (SSC). The SSC suggested that this group be charged with exploring approaches to incorporating and disseminating additional ecological information and providing guidance to the Council on policy matters. The Committees first met in Sitka on September 1996 to discuss the role and objectives of the committee. Most attendees agreed that the committee could serve as an educational forum and that the committee could interact with the plan teams as well as provide advice to the Council. The committee could also stimulate specific ecosystem related research projects and direction with regard to specific population goals for species covered in the fishery management plans.

Functions of the NPFMC Ecosystem Committee and Some Examples of Work in Progress

① Provide a platform for education on ecosystem topics
- ✔ AFSC workshop and program review
- ✔ bibliography of ecosystem literature
- ✔ interaction with other agencies, groups

② Obtain additional information on N. Pacific ecosystem
- ✔ traditional knowledge and wisdom
- ✔ local knowledge and fisheries data

③ Develop working definition for ecosystem management in context of NPFMC
- ✔ review other management schemes
- ✔ proposed definition for discussion

④ Develop policies for ecosystem-based management
- ✔ draft policy similar to habitat policy

⑤ Provide advice
- ✔ research priorities, adaptive management, habitat
- ✔ Magnuson-Stevens Act mandates

Ecosystem Research Workshop

In January 1997, the NPFMC's Ecosystem Committee met for a two-day workshop in Seattle. The workshop was put on by the Alaska Fisheries Science Center, National Marine Fisheries Service, and coordinated by Patricia Livingston. Committee members Dave Fluharty, Chris Blackburn, and Kristen Stahl-Johnson were present (Robin Samuelson and Linda Behnken had prior commitments), along with approximately 50 people who attended at least one day of the workshop. The meeting was conducted based on the attached agenda. A brief summary of each report is provided below. Copies of presentation overheads are available from the Council office.

What Constitutes an Ecosystem? Pat Livingston (AFSC) provided an overview of ecosystem definitions, important elements and processes, and the concept of ecosystem health. Bodkin (1990) defines an ecosystem as "a set of interacting species and their local, non-biological environment, functioning together to sustain life". Structural elements of an ecosystem include inorganic substances (C, N, CO_2, H_2O, etc.), organic substances (proteins, carbohydrates, lipids, etc.), climate regime (temperature, rainfall, etc.), producers (green plants), consumers (animals), and decomposers (bacteria, fungi, protozoa). Functional elements of ecosystems include energy flow circuits, food chains, diversity in time and space, nutrient cycles, development and evolution, and feedback control mechanisms (cybernetics). She discussed the dichotomy between this system-level view of ecosystems and the population-community approach to ecosystem study. The current strategy in ecosystem research is to integrate the two approaches by studying not only the processes influencing the distribution and abundance of organisms and the interactions among organisms but also to study the interactions between organisms and their role in transformation and flux of energy and matter. Studying population and community ecology is an essential aspect of ecosystem research. Ecosystem health as a concept was discussed. The concept is useful because it provides a focus for examining human activity and its effect on ecosystems. Defining ecosystem health is difficult, however, especially in systems such as the eastern Bering Sea where it is difficult to separate natural variability from human-induced changes. We are still in the early stages of attempting to find reliable indicators of ecosystem health. This effort may require monitoring of key ecosystem attributes. Biodiversity, its definitions and importance, were also discussed. Measurement of diversity and its changes requires regional scale research and monitoring. Because both perturbed and natural ecosystems are now present, efforts to maintain and restore biodiversity need to consider the value and stability of existing ecosystems.

The focus of current ecosystem-related research efforts is to study ecosystems at a variety of levels: population, community, and system levels. Depending on the questions being asked, this requires examination of processes at a variety of time and space scales, determination of key information on important populations, emphasis on trophic interactions, and understanding the effects of human activities. Presently, much attention is being given to examining the effects of physical factors on biological processes and spatial distributions of key marine species.

Fisheries-Oceanography Coordinated Investigations (FOCI) Rick Brodeur (AFSC) reviewed research investigations conducted under the FOCI program. FOCI was established in 1984 to gain an understanding of recruitment mechanisms of walleye pollock. The initial studies focused on pollock recruitment in the Shelikof Strait population of the GOA with an aim to understanding the physical and biological process which affect survival. Studies were conducted to determine spatial distribution of spawners and eggs, vertical distributions and mortality of the various life stages, trophic interactions, and finally development of biophysical models and management advice via stock projections. The Bering Sea FOCI program began in 1991 and focuses on stock structure and recruitment of walleye pollock in the Bering Sea. Many of the studies conducted in the GOA were continued in the BS but several new studies were initiated, including those on stock structure and onshore transport of eggs and larvae. Studies have examined differential survival of eggs and larvae over the Bering Sea slope and shelf, noting a coincidence of high concentration of larvae in eddies.

Rick also reported on the Southeast Bering Sea Carrying Capacity (SEBSCC) research program, which was established in 1996 and will run through the year 2001. A major research project under the SEBSCC program is to examine the distribution and ecology of juvenile pollock near tidal fronts at the Pribilof Islands. The presence of these fronts, which contain high densities of juvenile pollock and their predators in some years, may have impacts on juvenile pollock survival. Underwater examination by ROV indicated that juvenile pollock were associated with jellyfish, which may provide shelter for these pollock during the day and hence enhance survival. Results were also presented on another SEBSCC project which examined the distribution and species and habitat associations of forage fish, including juvenile pollock, in the Bering Sea from Russian and NMFS surveys going back to 1982. The overall distribution and diversity of forage fish available in various locations was contrasted between warm and cold years on the eastern Bering Sea shelf.

Pinniped Research Program Tom Loughlin (NMML) gave the group an overview of research conducted to understand declines of Steller sea lions and northern fur seals. Research on Steller sea lions has included foraging and food habit studies, physiology studies, prey surveys, and studies of other possible impacts (disease, contaminants, reproductive failure, predation, etc.). The decline of Stellers is chronic and widespread, and it appears that juvenile survival is the primary problem. Possible causes of the decline could be emigration, predation, harvest, pollution, disease, takes in fisheries, or changes in prey availability. Careful evaluation of these possible causes suggests that changes in prey availability is perhaps the biggest culprit. Food habit studies have indicated that diet has changed during the course of the decline by becoming more simplified and more focused on pollock or Atka mackerel. Primary prey are either small (<30 cm) mid-water schooling fish or various small demersal fishes. Juvenile diets appear more restricted that adults, and diet diversity is directly correlated with the amount of sea lion decline. That is, the largest declines have occurred in areas with fewer prey species available. Stellers now rely primarily on pollock, rather than other higher energy foods such as capelin. Studies using telemetry (satellite transmitters) have shown that young-of-the-year Steller sea lions do not range very far for food, and have limited diving capacity (<50 m). Hence, prey availability near rookeries and haulouts may be very important for survival.

Northern fur seal is another species of concern and focus of considerable research. The northern fur seal population began to decline in the mid-1970's for reasons that are not apparent. The two main breeding islands have shown different trends, with St. Paul Island showing stable pup production since the early 1980's, whereas the St. George Island pup production continued to decline until only recently. A new population of fur seals was established at Bogoslof Island in 1983 and has grown rapidly. Studies have focused on various aspects of the northern fur seal in relationship to its pelagic ecosystem. Foraging behavior studies using satellite transmitters have shown that these animals range far in search of food. Two typical diving patterns have been found for foraging behavior of lactating female fur seals. Shallow divers dive to 20-75 m at night feeding on pelagic prey. Deep divers dive 75-150 m throughout the day and night feeding near the shelf bottom. Many females combine these patterns when moving from deep to shallow water. Interestingly, fur seals from St. Paul appear to forage to the north and west, while those from St. George forage to the south and east of the island. Scat analysis indicates that juvenile pollock is the most common prey of fur seals from St. Paul. Fur seals from St. George consume a combination of pollock and squid.

The 1994 amendments to the Marine Mammal Protection Act (MMPA) provided for a Bering Sea Ecosystem Study Plan, which will provide for increased involvement of Alaska natives into ecological research. Once funded, research may begin in 1998.

Seabird Status and Research Vivian Mendenhall (USFWS) reviewed the status of seabirds and the importance of prey availability to seabird survival. In general, fish eating seabird populations in the Bering Sea are stable, following a decline of several species (red-legged and black-legged kittiwakes, thick-billed murres) through the early 1980's. Most seabird populations are limited by prey availability near nesting sites, particularly for those seabirds that are surface feeders. Some birds are able to make long forays (e.g., thick billed murres forage out to 100 km), whereas others remain closer to land in search of prey. Prey availability depends on fish stock size, local sea conditions (surface temperature, upwelling, etc.), and distribution. Energy content of forage fish varies greatly (20 fold), with myctophids and eulachon having the highest energy density, and cod and pollock the lowest. Hence, pollock may be unable to sustain successful breeding of some seabird species (except puffins). Effects of forage fluctuations on seabird populations vary with seabird species, depending on its foraging strategy, breeding strategy, and adaptability. Threats to seabirds include oil spills, logging (old growth required for murrelet nesting), predators (foxes, rats), tourism disturbance, bycatch in fishing gear, fishery waste discharges (may increase some populations of competitors or predators), and localized fishery removals of prey. Several research projects are ongoing to help understand seabird ecology. The Seabird, Marine Mammal, and Oceanography Coordinated Investigations (SMMOCI) project is examining the relationship of seabird population trends to forage fish biomass near colonies. The Alaska Predator Ecosystem Experiment (APEX) project is examining the relationship of seabird populations in the northern Gulf of Alaska to the availability of forage fish, including the influences of oceanography, forage fish selection by birds, and fish carcass composition. The PICES-GLOBEC International Program on Climate Change and Carrying Capacity project is international and multi disciplinary in nature.

Habitat Research Bob McConnaughey (AFSC) provided an overview of some habitat research being conducted by the AFSC. Habitat can be considered as the biotic-abiotic interface. This view is a composite of several terms including habitat (physical locality), ecological niche (environmental conditions), and biotope (location plus environmental conditions suitable for particular species). A few general principles underlie much of habitat (actually *biotope*) research: (1) a single species is not ubiquitous, thus habitat is restrictive; (2) a species is not uniformly distributed throughout its area of occurrence, thus habitat quality varies; and (3) there is significant temporal variability in habitat quality and location. In general, fish abundance reflects habitat quality. Because fish are able to select habitat, the best habitat is occupied first and at the highest density, while marginal areas are eventually occupied in response to crowding . As such, relative abundance is a reasonable first approximation of habitat quality. Current research includes environmental data collection, habitat characterization, environmental impacts of fishing, and analysis of community ecology. New technology (acoustic bottom typing, laser line systems and GIS) may allow for much improved data collection and analysis. Acoustic bottom typing enables passive collection of sea floor attributes during fishing and/or survey operations. Laser line systems function much like a towed camera system but it is useable in somewhat more turbid conditions. Habitat characterization research has focused on identifying limits and preferences of fish species, incorporating the effects of population size and describing associations with surface sediments. An investigation into the environmental impacts of bottom trawling in the Bering Sea was initiated last year. Comparison of heavily fished and unfished areas in Bristol Bay will assess chronic exposure effects. Experimental trawling in unfished areas in 1997 and beyond will provide information on acute exposure effects and the recovery process will be monitored. These studies will enable resource managers to evaluate the efficacy of time-area closures in soft-bottom areas. Similar studies are being conducted in harder bottom areas of the Gulf of Alaska using a submersible and video assessment technology. Additional planned studies include a retrospective analysis for the Gulf and a field study of trawl impacts in gorgonian coral habitat in the Aleutians. Potential changes in Bering Sea community ecology will be examined by comparing current fish assemblages with those identified in an earlier (1982) study. Various habitat research bottlenecks were discussed. These include the limited seasonal coverage of data collection, the general paucity of environmental data, frequently inconsistent data formats and potentially high data processing costs (e.g., infauna and video). There are additional resource constraints related to manpower and short-term funding cycles.

Essential Fish Habitat Cindy Hartmann (NMFS) briefed the group on Magnuson-Stevens Act requirements regarding essential fish habitat (EFH). As defined under the Act, EFH is "those waters and substrate necessary to fish for spawning, breeding, feeding, or growth to maturity". NMFS has developed a framework for guidelines to describe, identify, conserve, and enhance EFH. Comments on the Proposed Rule are due February 12, 1997. As proposed, EFH is the amount of habitat necessary to maintain a managed species at a target production level (note: default=MSY). EFH will be defined for each life history stage and will be presented in the FMP in the form of text, tables, and maps. Information used to determine EFH will be based on a hierarchical approach depending on data availability.

Proposed hierarchical approach to EFH.

Level 1. Presence/absence data
Level 2. Habitat-related densities of species
Level 3. Habitat-related growth, reproduction, or survival rates by habitat
Level 4. Production rates by habitat

Resource Ecology and Ecosystem Modeling Pat Livingston (AFSC) briefed the group on resource ecology and ecosystem modeling activities underway at the Science Center. Food habits data are collected from the dominant groundfish species in the eastern Bering Sea, Gulf of Alaska and Aleutian Islands regions. This sampling provides information on geographic distribution of prey, prey size composition, and diet composition by season, size, and sex. Geographic information may be particularly valuable when survey data are limited (e.g., capelin). These data are used to estimate the impacts of groundfish predation on species that are important to fish, birds, marine mammals, and fisheries. Information generated from single species can be brought together into a multi-species synthesis, giving estimates of diet similarity and habitat use by species, time series of groundfish predation mortality, marine mammal and seabird consumption, and providing insights into food web interactions and ecosystem change indicators. Pat has found that the food web in the Bering Sea has some differences from the Gulf of Alaska food web. For example, although walleye pollock are a dominant component of each system, pollock are highly cannibalistic in the BS, but not in the GOA. In general, the pelagic portion of the food webs the Bering Sea, Gulf of Alaska, and

Aleutian Islands is relatively separate from the demersal, inshore food webs. Multi-species modeling provides both retrospective information (predation mortality, recruitment estimates, historical biomass levels, etc.) and projections into the future (long-term effects of fishing strategies such as mesh size changes on multiple species or differential exploitation rates, effects of environmental change, and a guide to future research directions). Data gaps for multi-species forecast modeling include: information on the seasonal distribution, movements, and diet of groundfish.

Incorporating Predation and Climatic Effects into Stock Assessments Anne Hollowed (AFSC) provided an overview of incorporating predation and environmental information into stock assessment modeling. Food habit research provides information on daily rations, size, age and weight of prey, and annual estimates of consumption. Predators are incorporated into the assessment by modeling them as fisheries. For GOA pollock, studies have shown that arrowtooth flounder tend to be selective for age 1 pollock, and sea lions are selective for age 2+ pollock, whereas halibut tend to eat older pollock (3+). There is annual variability in the age composition of pollock consumed by predators, because of fluctuations in year class strength of pollock. This information coupled with information on the time series of predator abundance can then be used to estimate age specific mortality of pollock due to predation by various predators. Additional research on recruitment process of GOA pollock with the FOCI program has also proven to be useful in stock assessments. Information on environmental conditions during each early life history stage (eggs, larvae, juveniles) can be scored and tallied to provide fairly accurate predictions of year-class strength. Simulation modeling of the GOA pollock stock using stochastic recruitment at age 3 has provided estimation of probabilities of falling below threshold (defined as 20% of the unfished spawner biomass). The element of risk can thus explicitly incorporated into the plan teams ABC recommendation, as was the case in 1993.

Incorporating Ecological Information into Stock Assessment and Management Advice Lowell Fritz (AFSC) reviewed how oceanographic information is being incorporated into projections of Eastern Bering Sea (EBS) pollock recruitment, and analysis of fishery and Steller sea lion interactions. Pollock year-class size is variable in the EBS. In general, recruitment has been reduced at very high stock sizes. One hypothesis is that because pollock are cannibalistic in the EBS, large year-classes result when there is a high degree of spatial separation between adults and juveniles. There does appear to be some relationship between spatial separation and year-class strength, and this separation appears to be linked to larval drift. Computer models indicate that surface flows during April-July of years producing large pollock year-classes (1978, 1982, and 1989) pushed larvae into the inner and middle shelf areas of northern Bristol Bay, and away from the adult population on the outer shelf. Small year-classes are produced when larvae are not greatly dispersed away from outer shelf spawning areas. This technique provides insights into year-class strength well before it can be estimated by trawl survey data.

A review of fishery data has yielded insights into temporal-spatial considerations for fishery and Steller sea lion interactions. Trawl exclusion zones were established in 1992 around sea lion rookeries along the Aleutian Islands and Alaska Peninsula. Combined with the closure of the Bogoslof area to conserve Donut hole pollock, there was a significant redistribution of effort onto the Bering Sea shelf area north of Unimak Island, which contains critical habitat for Steller sea lions. The amount of pollock taken within critical habitat has increased since the mid-1980's, such that almost 70% of the total BSAI pollock catch was taken from these areas in 1995. Another study examined localized depletion of Atka mackerel in the Aleutian Islands. The fishery takes place in very small discrete areas, most of which are within the 20 nm critical habitat areas around Steller sea lion rookeries and haulouts. Analysis of fishery catch-per-unit-effort (CPUE) data indicate that localized depletion of Atka mackerel, a major food source for sea lions, can occur in these areas. These types of analyses are useful to managers considering ways to mitigate possible impacts of fisheries on Steller sea lions and refine previous management actions.

Overview of Ecosystem-Based Management Principles Dave Witherell (NPFMC) provided a brief overview of the literature on marine ecosystem-based management. As defined by the Ecological Society of

America, ecosystem management is "management driven by explicit goals, executed by policies, protocols, and practices, and made adaptable by monitoring and research based on our best understanding of the ecological interactions and processes necessary to sustain ecosystem composition, structure, and function". In more general terms, ecosystem-based management is shorthand for a more holistic approach, which focuses more on maintaining system integrity rather than maximizing extraction of certain resources.

A number of management measures previously adopted by the Council encompass ecosystem-based management principles (e.g., establishing a 2 million mt optimum yield cap, spatial and temporal allocation of groundfish harvest, incorporation of risk aversion and uncertainty, establishment of no-trawl zones, etc.). Since 1984, the Council's #1 comprehensive management goal (NPFMC 12/7/84) is to conserve fishery resources, maintain habitats, and give full consideration for interactions with other elements of the ecosystem. The Council has also had a comprehensive policy on habitat since 1988. The objectives of this policy are to maintain the current quantity and productive capacity of habitats, and restore and rehabilitate any habitats previously degraded.

The principles and elements of ecosystem management were identified in five published papers (Grumbine 1994, USFWS 1994, Mangle et al. 1995, Christiansen et al. 1996, Larkin 1996). The concept of ecosystem-based management includes the elements of sustainability, goals, ecological models and understanding, complexity, dynamic character, context and scale, adaptability, and humans as ecosystem components. A working definition for ecosystem-based management in the context of the North Pacific Fishery Management Council was proposed and discussed in the workshop group. The working definition, as revised, is shown in the adjacent box; additional changes may be made in the future.

Working Definition for Ecosystem-Based Management in the Context of the NPFMC - January 1997

Definition: Ecosystem-based management, as defined by the NPFMC, is a strategy to regulate human activity towards maintaining long-term system sustainability (within the range of natural variability as we understand it) of the North Pacific, covering the Gulf of Alaska, the Eastern and Western Bering Sea, and the Aleutian Islands region.

Objective: Provide future generations the opportunities and resources we enjoy today.

Principles:
1. Maintain biodiversity consistent with natural evolutionary and ecological processes, including dynamic change and variability.
2. Maintain and restore habitats essential for fish and their prey.
3. Maintain system sustainability and sustainable yields of resources for human consumption and non-extractive uses.
4. Maintain the concept that humans are components of the ecosystem.

Guidelines:
1. Integrate ecosystem-based management through interactive partnerships with other agencies, stakeholders, and public.
2. Utilize sound ecological models as an aid in understanding the structure, function, and dynamics of the ecosystem.
3. Utilize research and monitoring to test ecosystem approaches.
4. Use precaution when faced with uncertainties to minimize risk; management decisions should err on the side of resource conservation.

Understanding:
1. Human population growth and consequent demand for resources is inconsistent with resource sustainability.
2. Ecosystem-based management requires time scales that transcend human lifetimes.
3. Ecosystems are open, interconnected, complex, and dynamic; they transcend management boundaries.

Other Discussion

The group discussed the proposed essential fish habitat (EFH) guidelines. It was noted that the definition of EFH was habitat required for target production levels; many thought this was extremely vague and highly discretionary. Some present were concerned that this is another unfunded mandate, that will take staff time away from other, more useful projects. Additional funding should be made available if this is a priority project. As a way to save time and money, it was suggested that as a first step, a matrix of presence/absence of information be constructed. Such an information matrix table could have life history stage as columns, with each row a separate species. A simple check would indicate if the information was already available. It was felt that this table would help identify where data were available that could be subsequently analyzed and where data were lacking and new research is needed. It could also serve as a basis for setting priorities and new funding initiatives. It was suggested that critical habitat was more important than essential habitat, as these might be more discrete areas for managers to identify and protect. Another thought was that identifying "sensitive habitat" more vulnerable to impacts (attached invertebrates and plants) might be more useful than essential fish habitat for individual fish species. Another suggestion was to use existing closure areas as first approximation of critical habitat for herring, red king crab, hair crab, and halibut. One could also consider the "threats" and define what is the risk. NMFS staff is planning an informal session to discuss proposed EFH guidelines on the evening of February 5.

It was agreed that the ecosystem committee should meet on an informal basis during Council meetings to generate additional discussion and public involvement. An informal meeting of the Ecosystem Committee has been scheduled for 7 p.m. on Thursday, February 6 at the Anchorage Hilton Hotel. The group expressed its appreciation to Pat Livingston for coordinating an excellent workshop, and to all the speakers for their presentations.

<u>Attendance List:</u>

Dave Fluharty (committee chair)
Chris Blackburn (committee member)
Kristen Stahl-Johnson (committee member)
Dave Witherell (staff)
Gordon Kruse (advisor)
Pat Livingston (workshop coordinator)
Clarence Pautzke
Doug DeMaster
Warren Wooster
Tamra Faris
Lowell Fritz
Chuck Fowler
Ole Mathisen
Richard Brodeur
Sue Hills
Hal Weeks
Richard Ferrero
Bob McConnaughey
Vivian Mendenhall
Andrew Trites
Lennie Gorsuch
Ken Adams
Eric Swenson
Jerry Brennan
Gordon Blue
Richard Merrick

Dan Nichol
John Roos
Jude Henzler
Connie Sathre
Ann Hollowed
Ed Casillas
Dan Waldeck
Gretchen Harrington
Michiyo Shima
Craig Rose
Tiana Honkalehto
Fred Munson
Jeff Fujioka
Sandra Lowe
Loh-lee Loh
Jim Ianelli
Tom Wilderbuer
Tom Loughlin
Ross Anderson
John Field
Eric Weissmen
Mark Weissmen
Rich Marasco

~5 unidentified persons

<u>Note:</u> Please contact Dave Witherell (NPFMC staff) if you wish to obtain additional information, ecosystem-based management bibliography, or copies of presentation overheads. The Ecosystem Committee is seeking information and informal advice on how to obtain traditional ecological knowledge and wisdom as well as the experience and insights of local persons and other fishermen. Please submit these suggestions in writing to Dave W.

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[additional contributions are appreciated]

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